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The data given in this report were obtained in connection with the project for European Corn Borer Research conducted from the laboratory at Toledo, Ohio. Various federal and state agencies and individual seedsmen cooperated by providing the corn seed. Dr. J. R. Holbert, U. S. Bureau of Plant Industry, Bloomington, Illinois, provided 10 of the 12 strains and varieties reported on under Experiment A, 31 of the 42 strains planted in Experiment B, and 31 of the 136 inbreds planted in Experiment C. Other contributors with the States they represent are as follows: Messrs. G. H. Stringfield, Ohio; R. R. St. John, Indiana; A. A. Bryan, Iowa; N. P. Neal, Wisconsin; A. R. Marston, Michigan; H. K. Hayes, Minnesota; R. G. Wiggans, New York; A. M. Brunson, Kansas; G. F. Sprague, Missouri; Charles Burnham, West Virginia; E. J. Kinney, Kentucky; and W. R. Singleton, Connecticut.

The following discussion deals with a continuation of similar investigations reported in 1934. The investigations in 1935 were carried on under three major phases, viz: The testing of the relative borer resistance and tolerance of double cross hybrid strains of corn, in much the same manner as the 1934 work. The testing of the relative borer resistance and type of tassel emergence of single, 3-way, and double cross hybrid strains of corn which, in turn, initiated a study of single crosses chosen on the basis of the tassel characteristics of the inbreds used to produce the single crosses. The testing of the relative borer resistance of 136 inbred strains of corn, which was the first study of inbreds under corn-borer conditions from the standpoint of selecting desirable inbreds on the basis of their tassel emergence, and other plant characters that might be conducive to corn-borer resistance, for use in producing resistant single crosses.

THE RELATIVE BORER RESISTANCE OF DOUBLE CROSS HYBRID STRAINS OF CORN, INVOLVING INBREDS OF KNOWN TASSEL EMERGENCE CHARACTERISTICS

EXPERIMENT A

This experiment contained 8 double crosses involving inbreds Ill. R4, Ill. Hy, Iowa L317, and Ill. A48, known to possess to some degree the characteristic of delayed eclosion of the tassel, and inbreds Ill. A, Ind. TR, Ill. 90, and B.P.I. 540 (or ITE 701) not having this characteristic. Delayed tassel eclosion is a term used in this discussion to denote the delayed emergence of the tassel from the leaf wrappings composing the enveloping whorl. In addition single crosses Hy x R4 and A x TR were planted, in Experiment A, as standards for comparison. Local varieties Woodburn and Clarage were planted also.

These twelve strains of corn were replicated four times in each of the three plantings made on May 11, May 27, and June 11. The strains were distributed at random for planting in the 12 plots of each replication. Each half of each plot was two- by eight-hills in size, the halves being separated by four buffer hills to prevent the migration of young borers from one half to the other. Three plants of each of the 16 hills, in one half of each plot, were infested by hand with 4 egg masses of the corn borer, or about 124 eggs per plant; the other half of the plot was subject only to natural infestation by moths. The mean date of egg hatching was July 19. When the borers became mature, during the last two weeks of August, a plant at random from each of 12 hills in each half of each plot was dissected to determine the number of borers contained. The data used for the borer-resistant phase of the study and reported on in this report came from the half of each plot where infestations were made by hand. A sample of 12 x 4, or 48 plants, upon which about 5,950 borers had hatched was available as a basis for calculating the rate of borer survival on each strain of corn.

The mean numbers of mature borers per plant, resulting from the eggs placed on the plants by hand, plus those laid by the moths in nature, were 10.32, 5.50, and 3.20 for the May 11, May 27, and June 11 plantings, respectively. The mean percentages of borer survival on these plants were 7.59, 4.19, and 2.53 on the three plantings, respectively.

The mean number of mature borers per plant, including infested and non-infested plants, of all strains naturally infested was 1.29, 0.57, and 0.21 for the three plantings, respectively. The mean percentage of borer survival on these plants was 10.75, 7.92, and 7.78, respectively. The lowering of the rate of borer survival on the hand-infested plants is thought to have been due to the competition of the higher level of young borers and not to any loss of vitality of the borers hatching from the eggs produced in the laboratory.

RESULTS

EFFECT ON BORER RESISTANCE OF INCREASING THE NUMBER OF INBREDS POSSESSING DELAYED TASSEL ECLOSION IN PRODUCING DOUBLE CROSS HYBRIDS.

For this test, 3, 4, and 1 double crosses were available involving 2, 3, and 4 inbreds, respectively, which as inbreds were known to delay tassel eclosion. The purpose of this experiment was to determine whether increasing the number of inbreds, having delayed tassel eclosion in the pedigree of double crosses, would further delay tassel eclosion of the double crosses and hence further decrease the rate of borer survival.

The mean number of days from tasseling to silking, based on samples of about 90 plants, are given in table 1, for the May 27 and June 11 plantings, for each of the strains tested. The strains are grouped according to the number of inbreds having delayed tassel eclosion entering into their pedigrees. The silking dates and rates of borer survival for each planting are given in table 1. Referring to the plantings for which data are available, it may be noted that for double crosses involving 2, 3, and 4 inbreds having delayed tassel eclosion, the mean silking intervals are 37.7, 37.7, and 38.0 days, respectively. These three values are very nearly the same; hence, any differences among the groups, respecting tasseling and the resulting rate of borer survival, would be caused by characteristics of the tassel not associated with the maturity of the strains. Therefore, the differences between the values giving the number of days from tasseling to silking, i.e., 7.52, 6.88, and 5.59, (table 1), are an approximate measure of the effect, on the rate of borer survival, of introducing 1 and 2 inbreds having delayed tassel eclosion, into the pedigrees of double crosses already having 2 of the desired inbreds.

In the group of 3 double crosses, involving inbreds L317 and R4, L317 and Hy, and R4 and Hy, the number of days from tasseling to silking was 7.52 and the rate of borer survival was 4.32 percent. In the group of 4 double crosses, involving inbreds R4, Hy, and L317, or inbreds A 48, Hy, and L317, the number of days from tasseling to silking was 6.88 and the rate of borer survival was 3.67 percent. Since the difference of 0.65 percent in the rates of borer survival is statistically significant (odds of over 350 to 1), it appears that the adding of 1 inbred, possessing delayed tassel eclosion, to the 2, having this characteristic already present in the pedigrees of the hybrids, further delayed tassel eclosion 0.64 of a day and, as a result, a percentage decrease of about 15 occurred in the rate of borer survival.

In the case of the double cross, involving inbreds R4, Hy, L317, and A48, the number of days from tasseling to silking was 5.59, and the rate of borer survival was 3.07 percent. The differences between these values and the group of hybrids involving inbreds L317 and R4, L317 and Hy, and R4 and Hy, are 1.93 days and 1.25 percent. The difference of 1.25 percent is statistically significant with odds of over 1000 to 1. It appears that the adding of 2 inbreds, having delayed tassel eclosion, to the 2 with this characteristic already present in the pedigrees of the double crosses, further delayed tassel eclosion 1.93 days and as a result a percentage decrease of about 29 occurred in the rate of borer survival.

Apparently adding 2 inbreds, having delayed tassel eclosion, to the pedigrees of double crosses already involving 2 inbreds having the same characteristic, had about twice as much effect in reducing the rate of borer survival as the adding of 1 of the desired inbreds to the pedigree. It should be noted, however, that this conclusion can not be taken to apply generally. Since the experiment was conducted with such double cross hybrids, involving desired inbreds, as were available, the conclusions apply only to the specific combinations of certain inbreds making up the hybrids and to the plantings indicated, one of which was made much later than the normal time. The data do indicate that it is possible to effect increasingly greater and material reductions in the rate of borer survival on double cross hybrids by increasing the number of inbreds, possessing delayed tassel eclosion, up to the maximum number involved in a double cross.

GREATER WIDTH AND LENGTH OF TOP LEAVES AS A FACTOR DELAYING TASSEL ECLOSION AND HENCE REDUCING THE RATE OF BORER SURVIVAL.

The length, and basal and middle widths of each of the two top leaves of about 90 plants of each of the 12 corn strains of the May 27 planting were measured when the leaves were fully developed. From these measurements the mean leaf area, in square centimeters of the top leaves, was calculated. This measurement is given in table 2, together with the mean time between tasseling and silking, and the percentage of borer survival, for each of the strains designated according to the field number given it in table 1.

Table [illegible]. Effect of increasing the number of inbred strains of corn with delayed tassel eclosion that enter into the pedigree of double cross hybrid strains of corn on the delayed tassel eclosion of the hybrids and the rate of European corn borer survival on them, Toledo, Ohio, 1935.

Pedigree	Field number of strain	Inbreds with delayed tassel eclosion	Planting date: May 11 Silking date	May 11 Borer survival	May 27 From tasseling to silking	May 27 Silking date	May 27 Borer survival	June 11 From tasseling to silking	June 11 Silking date	June 11 Borer survival	Mean of all plantings: From tasseling to silking	Mean Silking date	Mean Borer survival
		number	days from June 30	percent	days	days from June 30	percent	days	days from June 30	percent	days	days from June 30	percent
Ill.AxInd.TR	1	0	28.5	11.40	9.56	34.3	6.78	9.10	41.7	4.34	9.33		
Local variety - Mast's Woodburn	13	0	26.6	11.13	--	33.0	6.62	8.69	40.5	3.75	8.69		
Local variety - Johnson's Clarage	11	0	23.6	11.95	--	30.6	8.54	7.97	38.5	4.97	7.97		
Means		0	26.2	11.48±.492		32.6	7.32±.406	8.59	40.2	4.35±.455	8.66	33.0	7.72±.262
(Ind.TRxIa.L317)X(Ill.R4xB.P.I.540)	9	2	31.6	5.46	6.74	37.3	2.89	6.68	44.2	2.03	6.71		
(Ind.TRxIa.L317)X(B.P.I.540xIll.Hy)	10	2	32.2	8.72	8.12	37.0	3.43	8.58	44.3	1.86	8.35		
(Ill.R4xIll.Hy) X(Ill.AxB.P.I.540)	7	2	32.2	7.73	7.45	36.6	3.48	7.56	43.9	3.26	7.51		
Means		2	32.0	7.30±.406	7.44	37.0	3.27±.218	7.61	44.1	2.38±.145	7.52	37.7	4.32±.161
(Ill.R4xIll.Hy) X(Ia.L317xITE701)	3	3	32.4	5.52	6.90	37.5	2.56	6.42	43.9	1.52	6.66		
(Ill.R4xIll.Hy) X(Ind.TRxIa.L317)	6	3	32.5	5.36	6.83	37.1	3.21	7.07	44.3	1.43	6.95		
(Ill.A48xIll.Hy)X(Ia.L317xITE701)	5	3	31.7	7.92	7.13	36.4	3.12	6.97	43.6	1.30	7.05		
(Ill.R4xIll.Hy) X(Ill.90xIa.L317)	8	3	32.2	5.94	7.10	36.6	3.77	6.58	44.2	2.42	6.84		
Means		3	32.2	6.18±.352	6.99	36.9	3.16±.169	6.76	44.0	1.66±.126	6.88	37.7	3.67±.140
Means - (Ill.R4xIa.L317)X(Ill.A48xIll.Hy)	4	4	32.3	4.36±.703	6.06	37.4	2.89±.378	5.12	44.2	1.97±.252	5.59	38.0	3.07±.279
Means - Ill.R4xIll.Hy	2	2	30.9	5.52±.703	4.05	36.4	3.06±.378	5.16	43.0	1.44±252	4.61	36.8	3.34±.279

Table 2

Strain number	Leaf area sq.c.	Days from tasseling to silking	Percentage of borer survival
1	194	9.33	6.78
9	229	6.71	2.89
11	230	7.97	8.54
6	235	6.95	3.21
5	240	7.05	3.12
4	245	5.59	2.89
3	252	6.66	2.56
7	252	7.51	3.48
13	258	8.69	6.62
10	259	8.35	3.43
8	275	6.84	3.77
2	308	4.61	3.06

These data taken as a whole, indicate that there is no obvious relation between leaf area of the top leaves and either days from tasseling to silking or rate of borer survival. But the leaf area of the top leaves of the resistant strain No. 2, Hy x R4, was 58.8 percent greater than that of the susceptible strain No. 1, A x TR. Also, the two top leaves of Hy x R4 remained wrapped around the tassels 4.72 days longer, or 50.6 percent longer, than did the corresponding leaves around the tassels of A x TR. No other strain in this experiment retained its top leaves around the tassel so long as did Hy x R4. Together with the tendency for leaf enclosure, it is the writer's opinion that long wide top leaves are conducive to a delay in tassel eclosion, and possibly to a tighter wrapping of the leaves around the tassel, thereby contributing largely to a lower rate of borer survival.

THE RELATIVE BORER RESISTANCE OF SINGLE CROSS AND MISCELLANEOUS 3-WAY AND DOUBLE CROSS HYBRID STRAINS OF CORN.

EXPERIMENT B

In this experiment 21 single crosses were planted on May 27. These were of all possible combinations of 7 inbreds as follows: Kansas Yellow Saline (K.Y.S.), Iowa L317, Woodworth's Ill. 5120, Ill. A48, Steigermeyer's Ill. 22, B.P.I. 540, and No. 617, all being provided by J. R. Holbert from the Bureau of Plant Industry experimental plots at Bloomington, Illinois. In addition, 4 other single crosses and 17 double and 3-way crosses were planted in the experiment, making 42 strains in all. These were planted in six-fold replication of two-by four-hill plots. The varietal sequence within the replications was at random. Six plants in each of the 6 plots of each strain were infested by hand with 3 corn-borer egg masses, or about 93 eggs, per plant. The mean date of egg hatching was July 25. The 36 plants were dissected during the last week of August, when the borers were mature, and the rate of borer survival was calculated. The rate of borer survival, the dates of tasseling and silking, and the differences between them are given in table 3. The mean tasseling and silking data for each strain are based on about 90 plants.

RESULTS

SINGLE CROSSES OF STRAINS HAVING DIFFERENT SEASONAL REQUIREMENTS.

Only 2 of the 42 strains, field numbers 6 and 42, tested in Experiment B sustained a rate of borer survival significantly less (2.00 x S.E. with odds 19 to 1) than would be expected on the basis of the time of tasseling, and no strain sustained a rate greater than would be expected on the same basis. This was determined by comparing the generalized standard error of the mean rate of borer survival as determined from the field data with the difference between this and the expected rate. The expected rate was calculated on the basis of the maturity of the strains (silking date) and the number of days from tasseling to silking, both factors being considered jointly. These values are given also in table 3 corresponding to the rates of borer survival as determined from the field data. With the odds given, 2 out of 40 strains would, on the average, differ from the estimated value more than twice the amount of the standard error through chance fluctuations in sampling. It appears doubtful, therefore, if even the 2 strains previously determined as having a significantly lower rate were in fact in this category. Hence, no strains in Experiment B can be considered with certainty to have a lower rate of borer survival due to any other cause than a later maturity or a delayed tassel eclosion.

However, on the basis of delayed tassel eclosion, some of the strains might have value in developing borer-resistant double crosses. There are 15 of the 42 strains that silked less than 6.6 days after the tassels appeared. These 15 strains may be classified as follows:

4 strains involving inbred R4; from tassels to silks, 5.3 days
3 " " " A48; " " " ", 5.1 "
5 " " " St22; " " " ", 5.4 "
1 strain " inbreds A48 and St.22 from tassels to silks, 3.8 days
(Ohio 20 x 32) x Ohio 56; from tassels to silks, 6.0 days
(Ohio 20 x 32) x Ohio 84; " " " " 5.6 "

Table 3. Mean dates of tasseling and silking with differences between them, and the rate of survival of borers hatching on July 25 on each of 42 strains of corn planted on May 27, 1935, near Toledo, Ohio.

Pedigree (The pedigree is given irrespective of the way the crosses were actually made)	Field number of strain	Rate of borer survival: Actual	Rate of borer survival: Calculated	Date of tasseling	Date of silking	Difference
		Percent	Percent	Days from June 30		Days
Ill.A48 X K.Y.S.	4	2.8±.48	2.2	37.8	43.1	5.3
No. 617 X K.Y.S.	2	2.1±.39	2.2	37.4	45.3	7.9
Ill. R4 X K.Y.S.	7	1.8±.34	2.2	37.2	42.2	5.0
(Ill.R4xHy) X K.Y.S.	8	2.2±.40	2.2	36.0	43.4	7.4
Ill. 5120 X K.Y.S.	3	2.8±.48	2.2	34.3	44.7	10.4
(Ill.R4xHy) X (Ill.R4xIa.L317)	42	1.4±.29	2.6	33.8	38.7	4.9
St. 22 X Ia.L317	12	2.7±.47	2.7	33.6	38.5	4.9
St. 22 X K.Y.S.	1	2.7±.47	2.7	33.3	39.6	6.3
St. 22 X Ill.5120	10	3.9±.65	2.7	33.3	38.0	4.7
Ia.L317 X K.Y.S.	5	1.9±.36	2.3	33.2	43.8	10.6
St. 22 X Ill.A48	11	2.7±.47	2.8	33.2	37.0	3.8
B.P.I. 540 X K.Y.S.	6	1.5±.30	2.3	32.6	43.5	10.9
Ia.L317 X Ill.A48	21	2.8±.48	2.9	32.4	37.9	5.5
ITE701 X Ill.A48	22	2.4±.43	2.9	32.3	36.7	4.4
No. 617 X Ill.A48	24	3.0±.52	3.2	31.4	38.2	6.8
St. 22 X B.P.I. 540	13	4.7±.76	3.2	31.1	37.0	5.9
No. 617 X Ia.L317	25	3.4±.57	3.5	30.6	39.0	8.4
(Ohio 56x61)X(Ill.R4 x Ohio 20)	33	3.6±.60	3.3	30.5	35.4	4.9
Ill.R4 X Ill.Hy	35	2.8±.48	3.5	30.3	36.8	6.5
Ill.5120 X Ill.A48	27	3.2±.55	3.6	30.2	38.1	7.9
Ill.5120 X Ia.L317	19	4.2±.69	3.5	30.2	39.6	9.4
(Ind.TRxIll.Hy)X(Ill.R4xPR)	17	4.2±.69	3.6	30.1	37.7	7.6
St.22 X No. 617	9	4.9±.80	3.5	30.0	35.2	5.2
(Ill.AxHy)X(Ill.R4xIa.L317)	15	4.0±.67	3.8	29.6	37.4	7.8
(Ohio 20x32) X Ill.R4	38	3.0±.52	3.8	29.5	36.3	6.8
Ia.L317 X ITE701	23	3.7±.62	3.9	29.5	38.6	9.1
(Ohio 20x32) X Ohio 56	37	3.6±.60	3.8	29.2	35.2	6.0
(Ohio 61x73) X (Ill.R4xOhio 20)	34	3.7±.62	3.9	28.9	35.5	6.6
Ill. 5120 X ITE701	20	4.6±.75	4.9	28.4	37.6	9.2
(Ind.WF9xTR) X (Ill.R4xHy)	28	4.6±.75	4.8	28.4	36.7	8.3
(Ill.AxHy) X (Ind.TRxIa.L317)	16	6.4±1.01	5.0	28.3	37.5	9.2
(Ill.R4xHy) X (Ind.66xTR)	30	5.4± .86	5.1	28.2	36.6	8.4
(Ohio 20x32) X Ohio 84	40	4.8± .77	4.0	28.0	33.6	5.6
(Ind.TRxIll.R4) X (Ill.AxHy)	18	6.9±1.08	5.2	27.9	36.1	8.2
Iowa double cross No. 13	41	5.0± .81	5.7	27.8	37.1	9.3
(Ohio 51xInd.TR)X(Ill.R4xOhio 20)	32	6.4±1.01	5.6	27.6	35.8	8.2
No. 617 X B.P.I. 540	26	8.6±1.32	6.9	27.1	36.9	9.8
No. 617 X Ill.5120	14	7.1±1.11	7.5	26.6	36.6	10.0
(Ill.KxR4) X (Ind.66xTR)	31	9.4±1.44	8.2	26.2	36.2	10.0
(Ind.WF9xIll.Hy) X (Ind.66xTR)	29	8.7±1.35	8.8	25.9	36.0	10.1
Ill.A X Ind. TR	36	10.7±1.61	9.8	25.3	34.5	9.2
(Ohio 20x32) X Ohio 65	39	9.2±1.41	10.2	25.0	33.9	8.9
Means		4.37	4.21	30.5	38.0	7.5

There were 4 strains involving inbred A and 9 strains involving inbred TR, averaging 8.6 and 8.8 days, respectively, from tasseling to silking. Single cross A x TR has been considered one of the most susceptible to the corn borer, and it appears that this susceptibility is due to the undelayed tassel eclosion of both inbreds A and TR in conjunction with a relatively early maturity.

Single crosses that deserve consideration, from the standpoint of yield and reduction in the rate of borer survival due to delayed tassel eclosion, are those listed in table 4.

Table 4

Pedigree	Yield-bu. per acre	Days from planting to silking	Days from tasseling to silking	Estimated Percentage of borer survival: No delay in tassel eclosion	Estimated Percentage of borer survival: Delay in tassel eclosion	Percentage reduction in rate of borer survival
St. 22xL317	116.0	72.5	4.9	4.6	2.7	41
St. 22x540	116.5	71.0	5.9	6.9	3.2	54
701 x A48	116.8	70.7	4.4	7.2	2.9	60
L317 x A48	109.2	71.9	5.5	5.4	2.9	46
St. 22x5120	99.4	72.0	4.7	5.2	2.7	48
St. 22xA48	96.0	71.0	3.8	6.8	2.8	59
Means		71.5	4.9	6.0	2.9	51

The estimated mean percentage of borer survival, 2.9, calculated on the basis of delayed tassel eclosion, compares with 3.2 percent, the mean determined directly from the field data.

The estimated percentages of borer survival in table 4 were calculated first, on the basis of the joint effect of maturity (silking date) and the delay in tassel eclosion (days from tasseling to silking) and second, on the basis of the joint effect of maturity and no delay in tassel eclosion (9.8 days from tasseling to silking) according to the methods outlined in the following section.

THE RATE OF BORER SURVIVAL AS AFFECTED BY THE COMBINED FUNCTION OF THE MATURITY OF CORN STRAINS AND THE NUMBER OF DAYS FROM TASSELING TO SILKING.

Past experiments have shown conclusively that the relative rate of borer survival on different strains is largely dependent on the availability, to newly hatched larvae, of the tassels as measured by the mid-date of tassel appearance. The date of tassel appearance within a planting is the result of two factors, namely, the maturity of the strain as measured by the number of days from planting to silking and the number of days from tasseling to silking. If all strains silked the same number of days after they tasseled, a difference of a day in maturity or silking would be equivalent to a difference of a day in tasseling, in changing the rate of borer survival. A decrease in the number of days from tasseling to silking of strains of equal maturity delays tassel eclosion to the same extent or causes the strains to tassel as many days later. Thus, the delay in tassel eclosion and the maturity of the corn as measured by the number of days from planting to silking are the components of the final effect in reducing the rate of borer survival.

In Experiment B, it was found that a delay in tassel eclosion, in strains silking early, had a much greater effect on the rate of borer survival than a delay in tassel eclosion in strains silking late. In other words, the rate of borer survival is a joint function of the maturity of the strains and the delay in tassel eclosion. It was necessary, therefore, to estimate the percentage of borer survival for different combinations of silking date and days from tasseling to silking in order to determine, for strains of given maturity, the effect any given delay in tassel eclosion would have on reducing the rate of borer survival. This was done by methods used in solving joint functions. Then the estimates of rate of borer survival on each strain obtained by these methods were checked with the estimates obtained directly from the curve of average relationship between mean tasseling date and rate of borer survival and were found to agree closely, thus checking the accuracy of the methods.

For strains of given maturity, the rate of borer survival, according to the number of days from tasseling to silking, may be observed from table 5.

Table 5

Silking date	Number of days after egg hatching	Percentage of borer survival						
		Days from tasseling to silking						
		4	5	6	7	8	9	10
August 3	9	3.4	3.7	4.1	4.9	7.4	10.4	
4	10	3.2	3.4	3.8	4.4	6.0	8.6	10.4
5	11	3.0	3.2	3.5	4.0	5.0	6.9	8.6
6	12	2.8	3.0	3.3	3.6	4.2	5.4	6.8
7	13	2.6	2.8	3.0	3.3	3.7	4.3	5.2
8	14	2.5	2.6	2.8	3.0	3.3	3.6	4.1
9	15	2.4	2.4	2.6	2.7	3.0	3.2	3.4
10	16	2.3	2.3	2.4	2.5	2.7	2.8	3.0
11	17	2.2	2.2	2.3	2.4	2.5	2.6	2.7
12	18	2.2	2.2	2.2	2.2	2.3	2.4	2.4

For strains silking on August 3 and 4, or 9 and 10 days after egg hatching, a delay of 5 days in tassel eclosion decreased the percentage of borer survival from 10.4 to 3.4. This is a decrease of 67.3 percent. For strains silking on August 6, or 12 days after egg hatching, a delay of 5 days decreased the percentage from 6.8 to 3.0, or a decrease of 55.8 percent. When the silking date was on August 8, or 14 days after egg hatching, the rate of borer survival decreased from 4.1 to 2.6, a percentage decrease of 36.6 . When the silking date was on August 10, or 16 days after egg hatching, the rate of borer survival was decreased 23.3 percent. When the silking date was August 12, or 18 days after egg hatching, any delay in tassel eclosion was ineffective in materially reducing the rate of survival.

From these data it may be concluded that a material reduction in the rate of borer survival can be effected by breeding strains of corn that delay their tassel eclosion as much as 5 days and whose mid-silking date is no more than 16 days after the mean hatching date of the borer eggs. Also, on strains whose mid-silking date is no later than 9 and 10 days after the mean date of borer hatching, reductions of about 29 and 17 percent, respectively, can be made by delaying tassel eclosion even as much as 1 day, and when the strains silk no later than 12 days after the mean date of borer hatching, reductions of about 38 percent can be made by delaying tassel eclosion as much as 2 days.

Considering the data from the alternative point of view, by planting strains that require 9 days longer to reach the silking stage and providing these strains do not silk before 18 days after the mean date of borer hatching, reductions of about 77, 69, 55, 46, 41, and 35 percent in the rate of borer survival can be made with strains delaying tassel eclosion 1, 2, 3, 4, 5, and 6 days, respectively. From the data for strains with a normal emergence of the tassels (about 10 days between tassels and silks) it may be noted that the rate of borer survival on strains silking 15 days after borer hatching was 3.4 percent compared with 10.4 percent on strains silking 10 days after borer hatching. This delay of 5 days in the maturity of strains, tasseling normally, caused a reduction of 67.3 percent in the rate of borer survival. Since this reduction is the same as that obtained with the strains silking 10 days after borer hatching but delaying tassel eclosion 5 days, it follows that the effect of 5 days delay in tassel eclosion on decreasing the rate of borer survival on these strains was equal to the reduction effected on strains tasseling normally but requiring 5 days longer to reach the silking stage. Five days delay in tassel eclosion was also equal in effect to 5 days longer for seasonal requirements when the two comparisons are based on the data from strains silking 9 days after borer hatching but having 9 days between tasseling and silking instead of the normal 10 days. From these comparisons and a further study of the data it appears that, in general, delaying tassel eclosion is as effective, in reducing borer survival, as delaying the time of appearance of the tassels an equal number of days by the use of strains that possess longer seasonal requirements.

INBRED EXPERIMENTS

EXPERIMENT C

In order to explore further the possibility of revealing characters other than tassel eclosion that might contribute to corn-borer resistance, 136 inbred strains, representing a wide range in type of field corn, were planted on May 27. Studies of the association of tassel development with corn-borer survival were an integral part of the work with these inbreds, including specific determination of those inbreds that have delayed tassel eclosion, in addition to those already known to have this character. The strains were planted in two plots two-by-three hills in size. The inbred sequence within each of the two replications containing one plot of each inbred was at random. The total number of plants in the two plots of each inbred after thinning was 30, distributed among the 12 hills as follows: three 1 plant-, three 2 plant-, three 3 plant-, and three 4 plant-hills. Each plant was infested by hand with 3 egg masses (about 93 eggs) and the mean date of hatching of these was July 28. Since the tassels of

10 inbreds were so far advanced in development by this date, the data from these were not considered comparable to those secured from the other inbreds and they were not used in any of the calculations. The tasseling and silking dates and number of mature borers were determined for each plant. The extended leaf height was recorded for each hill on July 26. The length, basal width, and middle width, were recorded for all the leaves of one typical plant of each inbred both at the beginning and at the end of the period during which eggs were placed on the plants. The leaf area of each of the two different plants of each inbred was calculated and divided by the extended leaf height of the plant at the time the leaves were measured, giving an index of bushiness, in terms of square centimeters of leaf area, per centimeter of height. The mean of the two indexes, from each inbred, is given in table 6. The generalized standard error, of the mean index of bushiness, was found to be 1.84. Calculating from this value, little weight (odds 19 to 1) should be placed in the differences between the indexes of any two inbreds of less than 5.2. The range in the values, of the index of bushiness, given in table 6 is from 16.1, indicating sparsely or narrow leaved inbreds, to 36.7, indicating many or wide leaved inbreds.

The rate of borer survival was considerably greater on the inbreds than on the single and double crosses planted on the same date. Associated with the higher rate of borer survival on the inbreds there was an equally greater variability in the survival rate as a result of chance fluctuations in sampling the inbreds (within inbred variability). This was to be expected, but this greater variability of the inbreds hid the underlying relationship between the survival rate and date of tasseling when the data were analyzed according to the methods for a joint function that were followed in Experiment B. The data were finally analyzed according to the more usual methods of grouping, without being able to study the effect of different combinations of silking dates and days between tasseling and silking on the rate of borer survival.

RESULTS

BORER RESISTANCE DUE TO TASSELING OF THE INBREDS

To study the rate of borer survival on inbreds tasseling on different dates, the data from the 126 available inbreds given in table 6 were listed according to their tasseling date. Then 7 groups, each of 18 inbreds, were made and the mean values determined for each group. These are given in table 7.

Table [illegible]6. Mean dates of tasseling and silking with differences between them, and the rate of survival of borers hatching on July 28 on each of 136 inbred strains of corn planted on May 27, 1935, near Toledo, Ohio.

Inbred with field number		Rate of borer survival Actual	Rate of borer survival Calculated	Tasseled	Silked	Difference	Height on July 26	Leaf area per cm. height
		Percent	Percent	Days from June 30			cms.	sq. cms.
Seed contributed by J. R. Holbert, Illinois								
S29	27	10.5±1.63	10.6	25.2	39.4	14.2	144	24.4
A	10	11.2±1.80	10.6	25.6	38.5	12.9	132	28.7
NI-1	15	12.9±2.25	10.5	26.7	36.0	9.3	140	26.8
S1	22	7.2±1.22	10.5	27.4	41.2	13.8	146	26.4
S2	23	9.5±1.40	10.5	27.0	37.5	10.5	136	25.6
S56	32	14.7±2.72	10.5	27.3	37.6	10.3	150	27.2
S31	29	6.9±1.20	10.4	28.1	38.4	10.3	134	26.9
4094	13	8.0±1.27	10.4	27.9	36.9	9.0	147	26.8
K	11	8.8±1.33	10.4	28.1	41.0	11.9	122	24.4
D2	17	11.4±1.86	10.4	27.7	38.4	10.7	165	28.5
D4	19	8.5±1.30	10.2	29.2	39.6	10.4	151	25.9
S17	25	11.1±1.78	10.3	28.8	40.1	11.3	134	20.7
S28	26	10.0±1.50	10.3	28.9	40.2	11.3	140	23.9
S38	31	12.2±2.08	10.2	29.8	40.8	11.0	141	31.9
S30	28	13.4±2.38	10.2	29.6	38.2	8.6	129	21.9
S13	24	14.7±2.72	10.2	29.8	39.1	9.3	165	25.3
D7	20	8.1±1.28	10.2	29.8	39.7	9.9	152	27.8
Km2	14	9.6±1.42	10.2	29.7	43.7	14.0	176	28.7
A48	109	9.7±1.43	8.8	31.1	38.0	6.9	167	28.0
S55	33	7.6±1.25	8.8	31.1	38.4	7.3	152	24.3
S37	30	11.0±1.75	9.3	30.7	39.8	9.1	148	27.9
NI-3	12	10.4±1.61	9.5	30.6	40.3	9.7	163	26.2
L	9	8.9±1.34	8.5	31.3	40.5	9.2	151	29.6
Hy	2	9.3±1.37	8.5	31.3	40.3	9.0	170	29.6
90	8	11.2±1.80	8.3	31.5	41.6	10.1	129	27.0
St.22	110	9.9±1.47	7.6	33.0	40.4	7.4	150	29.2
D8	21	10.5±1.63	7.3	34.4	42.5	8.1	141	25.6
D3	18	8.9±1.34	7.3	35.1	40.9	5.8	166	28.2
R4	1	5.1±1.05	7.2	35.6	42.4	6.8	143	25.6
5120	111	6.4±1.15	7.1	38.2	46.9	8.7	135	29.2
KYS	16	5.5±1.08	7.0	40.7	52.0	11.3	145	29.7
Seed contributed by W. R. Singleton, Conn.								
243	135	12.0±2.02	10.5	27.5	42.2	14.7	154	23.3
20	136	7.9±1.27	10.5	27.1	41.3	14.2	160	23.5
21	137	9.3±1.38	9.0	30.9	41.1	10.2	160	25.8

Table 6 continued

Inbred with field number		Rate of borer survival Actual	Calculated	Tasseled	Silked	Difference	Height on July 26	Leaf area per cm. height
		Percent	Percent	Days from June 30			cms.	sq. cms.
Seed contributed by N. P. Neal, Wisconsin								
1323	69	-----	10.6	20.7	31.3	10.6	174	20.1
3	65	12.6±2.18	10.6	23.3	35.8	12.5	154	21.3
R3	64	9.2±1.36	10.6	24.9	36.9	12.0	164	25.5
6	66	10.4±1.61	10.6	24.7	35.4	10.7	156	22.4
1350	71	----	10.6	25.0	36.4	11.4	166	25.4
1353	72	10.2±1.55	10.6	25.1	37.5	12.4	149	31.7
1439	78	8.1±1.28	10.5	25.9	39.6	13.7	159	23.6
1484	76	10.1±1.53	10.5	26.0	36.3	10.3	180	25.7
1445	75	11.6±1.92	10.5	26.6	40.8	14.2	163	24.6
9900	79	12.6±2.18	10.4	27.6	36.4	8.8	164	25.5
1367	73	9.3±1.38	10.4	27.9	39.1	11.2	129	24.5
1342	70	7.3±1.23	10.4	28.0	39.4	11.4	142	24.0
26	68	10.1±1.53	10.4	28.2	36.2	8.0	147	31.2
1374	74	9.3±1.37	10.2	29.2	40.4	11.2	163	26.1
1502	77	11.6±1.92	9.3	30.7	40.3	9.6	142	31.3
23	67	6.3±1.15	9.2	30.8	38.8	8.0	158	24.1
Kutius	138	6.5±1.16	7.4	33.9	44.4	10.5	169	27.8
Seed contributed by A. A. Bryan, Iowa								
J.S.153	115	----	10.6	21.7	29.9	8.2	134	21.2
Bl 356	42	11.7±1.95	10.6	24.7	43.1	18.4	143	21.9
OS 420	34	11.9±2.00	10.5	25.8	39.0	13.2	163	25.6
I 233	112	10.8±1.71	10.5	27.0	42.4	15.4	129	21.6
4Co 82	114	12.0±2.02	10.5	26.7	35.0	8.3	146	24.4
OS 426	35	11.8±1.97	10.3	28.7	39.1	10.4	163	25.9
L 289	36	10.4±1.61	10.2	29.7	42.2	12.5	157	21.8
ITE701	5	8.1±1.28	9.9	30.3	42.6	12.3	157	20.6
I 198	43	8.4±1.30	10.2	29.5	42.2	12.7	151	23.7
I 224	116	6.9±1.20	9.9	30.3	40.3	10.0	170	26.9
Bl 349	41	9.2±1.37	9.6	30.6	41.5	10.9	159	24.0
MC 401	39	10.0±1.50	9.7	30.5	45.7	15.2	155	22.8
I 205	38	6.7±1.18	9.2	30.8	38.8	8.0	142	22.6
540	4	10.6±1.65	9.7	30.5	42.0	11.5	155	19.1
Dr 276	44	8.8±1.33	8.3	31.5	43.5	12.0	122	24.3
L 234	37	7.3±1.23	7.5	33.6	41.5	7.9	148	22.4
Bl 345	40	7.7±1.25	7.3	34.5	42.7	8.2	123	30.6
L 317	3	3.3±0.90	7.2	36.2	46.8	10.6	148	23.6
Seed contributed by G. F. Sprague, Mo.								
1	91	8.5±1.30	7.1	38.7	49.2	10.5	116	28.7
7	90	9.2±1.37	7.0	42.9	48.7	5.8	145	26.4
4	92	6.8±1.18	7.0	42.5	48.5	6.0	128	26.3

Table 6 continued

Inbred with field number		Rate of borer survival: Actual	Rate of borer survival: Calculated	Tasseled	Silked	Difference	Height on July 26	Leaf area per cm. height
		Percent	Percent	Days from June 30			cms.	sq. cms.
Seed contributed by A. R. Marston, Michigan								
1457	50	----	10.6	24.0	32.6	8.6	162	25.9
107	51	9.9±1.48	10.5	25.8	40.3	14.5	165	21.5
137	47	13.8±2.48	10.5	26.6	40.6	14.0	141	22.4
1458	48	9.6±1.40	10.5	26.5	36.6	10.1	165	25.6
1450	53	9.6±1.40	10.3	28.8	37.5	8.7	180	23.6
M.A.275	46	9.2±1.36	10.3	29.1	42.6	13.5	129	21.3
118	55	8.1±1.28	8.7	31.1	41.7	10.6	134	21.9
106	52	5.6±1.09	8.3	31.6	43.1	11.5	156	18.2
M.A.225	45	5.7±1.10	8.3	31.6	45.8	14.2	172	23.8
101	54	6.9±1.19	7.8	32.6	42.5	9.9	151	24.1
77	49	4.4±1.00	7.5	33.5	44.7	11.2	125	16.3
Seed contributed by R. G. Wiggans, N. Y.								
2	117	----	10.6	20.5	30.9	10.4	170	18.9
164	118	10.1±1.53	10.6	22.7	33.2	10.5	136	19.2
350	120	----	10.6	22.6	36.0	13.4	161	20.1
1	122	13.6±2.44	10.6	23.1	37.2	14.1	174	26.4
19	121	6.3±1.15	10.6	24.5	39.0	14.5	145	22.9
3	123	13.8±2.48	10.5	26.0	38.4	12.4	151	20.2
79	124	13.7±2.46	10.6	25.5	37.4	11.9	144	21.5
H698	125	14.8±2.75	10.6	25.6	38.4	12.8	148	21.6
H697	126	10.4±1.61	10.5	25.9	38.8	12.9	167	16.1
143	119	11.5±1.90	10.4	27.8	38.3	10.5	141	17.9
Seed contributed by G. H. Stringfield, Ohio								
87	63	7.2±1.22	10.5	27.1	42.3	15.2	157	24.6
20	57	8.7±1.32	10.3	28.8	38.8	10.0	152	22.1
32	56	7.3±1.23	10.0	30.1	40.2	10.1	181	23.2
61	60	10.1±1.53	9.8	30.4	36.8	6.4	199	26.8
73A	58	8.7±1.32	9.7	30.5	41.3	10.8	159	28.9
47	62	9.1±1.35	8.6	31.2	42.6	11.4	155	26.7
10	61	10.4±1.61	9.5	30.6	43.0	12.4	170	29.2
02	59	5.2±1.06	7.1	37.7	41.7	4.0	152	20.4
Seed contributed by R. R. St. John, Indiana								
WF9	7	10.2±1.55	10.5	26.1	37.7	11.6	161	28.4
TR	6	11.6±1.92	10.4	28.3	38.7	10.4	177	33.2
B2	82	7.5±1.24	8.3	31.6	39.5	7.9	154	27.0
38-11	80	9.7±1.43	7.6	32.9	45.9	13.0	172	24.8
T92	81	5.2±1.06	7.2	35.6	44.5	8.9	161	29.1

Table 6 continued

Inbred with field number		Rate of borer survival		Tasseled	Silked	Difference	Height on July 26	Leaf area per cm. height
		Actual	Calculated					
		Percent	Percent	Days from June 30			cms.	sq. cms.
Seed contributed by A. M. Brunson, Kansas								
Y.S.51	132	7.2±1.22	9.2	30.8	46.2	15.4	138	30.7
P.S.55	128	7.7±1.25	9.5	30.6	44.8	14.2	143	32.9
Hg 28	130	8.5±1.30	8.3	31.6	41.1	9.5	130	29.2
HY 26	133	9.6±1.42	8.2	31.7	43.3	11.6	135	23.8
Hg 26	134	6.8±1.18	7.6	33.0	40.0	7.0	132	29.2
Y.S.58	129	7.5±1.24	7.3	34.9	45.3	10.4	148	25.1
9018	127	9.3±1.37	7.0	42.2	48.7	6.5	158	28.3
Y.S.56	131	4.9±1.04	7.0	46.0	50.5	4.5	108	28.3
Seed contributed by E. J. Kinney, Kentucky								
50	107	11.5±1.90	10.3	28.9	42.4	13.5	187	23.3
55	108	14.7±2.73	10.3	29.0	42.7	13.7	152	21.6
41	102	14.0±2.55	9.9	30.3	45.1	14.8	164	24.1
30B	104	9.6±1.41	7.6	33.1	43.8	10.7	142	25.5
27	101	7.5±1.23	7.6	33.2	45.7	12.5	166	21.9
39	105	7.5±1.23	7.2	35.5	44.1	8.6	162	25.9
21	106	5.9±1.12	7.1	37.2	45.5	8.3	168	24.7
58	103	6.8±1.18	7.0	41.7	44.7	3.0	132	36.7
Seed contributed by C. R. Burnham, W. Va.								
17	83	8.0±1.28	7.6	33.0	45.3	12.3	157	24.2
19	84	7.3±1.22	7.3	34.4	48.5	14.1	134	32.2
23	85	8.5±1.30	7.1	39.0	51.6	12.6	147	25.0
22	86	9.7±1.43	7.0	39.4	45.8	6.4	135	18.3
84	88	10.8±1.71	7.0	42.2	50.3	8.1	136	27.5
93	89	4.6±1.02	7.0	39.4	Late	?	166	17.2
Seed contributed by H. K. Hayes, Minnesota								
176	93	9.3±1.38	10.6	21.2	33.6	12.4	140	16.1
108	95	8.1±1.28	10.6	22.3	32.8	10.5	144	21.7
24	98	7.3±1.22	10.6	24.2	36.9	12.7	143	22.2
9	99	----	10.6	23.5	32.9	9.4	135	17.4
8	100	8.9±1.33	10.6	25.3	37.5	12.2	158	21.9
156	96	----	10.6	25.3	33.2	7.9	172	20.5
40	94	9.2±1.36	10.4	27.4	35.7	8.3	144	18.8
27	97	6.1±1.13	8.3	31.6	40.1	8.5	152	22.9

Table 7

Tasseling date - days from June 30	Days from tasseling to silking	Percentage of borer survival
24.4	12.8	10.58
26.6	12.1	10.52
28.3	10.9	10.37
29.9	11.3	10.12
31.0	10.2	8.87
32.8	10.4	7.66
38.4	7.9	7.08

When the inbreds were listed according to their silking date and the mean values of similar groupings determined, the results were those given in table 8.

Table 8

Silking date - days from June 30	Days from tasseling to silking	Percentage of borer survival
35.8	10.3	10.52
38.1	10.4	10.57
39.5	10.8	9.21
40.6	10.7	9.59
42.1	11.3	8.88
43.8	11.5	8.72
47.6	10.3	7.55

When the inbreds were listed according to the number of days between tasseling and silking and the mean values of similar groupings determined, the results were those given in table 9.

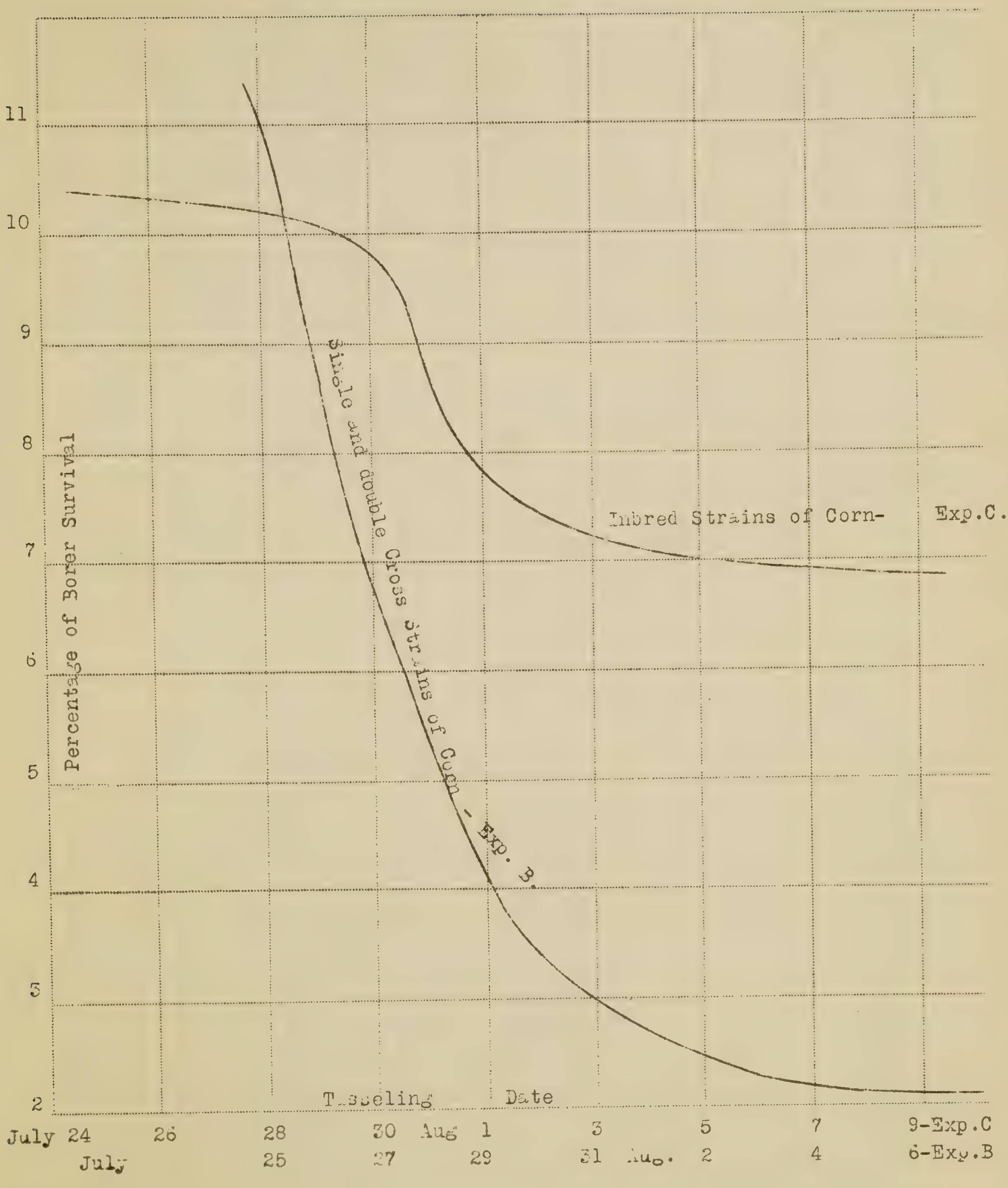
Table 9

Number of days between tasseling and silking	Silking date-days from June 30	Percentage of borer survival
6.42	42.3	7.84
8.58	40.9	8.96
9.96	39.7	9.85
10.68	40.4	8.95
11.66	41.2	9.13
12.80	40.8	10.67
14.38	42.2	9.63

By referring to table 7, it may be observed that the decrease in the rate of borer survival was greatest for inbreds tasseling between 30 and 33 days from June 30. When the rate of borer survival is plotted against the tasseling date and a free hand curve drawn in (figure 1) it is seen that the curve flattens out, both at the beginning and at the end of the tasseling period, but between July 30 and August 2 the rate of borer survival decreases sharply. This was between 2 and 5 days after borer hatching when the young borers were becoming established and during the most critical time of their development. Unavailability of the tassel buds for protection and food during this period caused the death of 23.6 percent of the number of borers that would have survived if the tassels had been fully available.

A comparison between the rate of borer survival on the inbreds and that on the single and double crosses planted on the same date is of interest. The rate of survival curve for Experiment B is drawn in for the purpose in figure 1. This curve is set over to the right three days because the mean date of borer hatching was three days earlier in Experiment B. Points on the curve for Experiment B are comparable, therefore, to points directly above on the curve for Experiment C with respect to the number of days from borer hatching to the tasseling of the strains.

It may be observed that the rate of borer survival on the inbreds tasseling so late that the tassels were not a factor in borer survival was found to be 7 percent, whereas a comparable rate of survival on the single and double crosses planted on the same date in Experiment B was found to be 2.2 percent. Rain probably accounted for much of this greatly decreased rate of survival on Experiment B. Experiment B was infested with nearly all of its complement of egg masses on July 24. Within the next 24 hours 0.44 of an inch of rain fell just when the eggs were hatching, probably washing many of the young borers from the plants. The mean date of egg hatching on Experiment C was July 28. The weather was ideal for the establishment of the young borers during the next five days, 0.35 of an inch of rain falling on August 2. Since the borers would have gained access to the tassel buds for protection during the five days it is not probable the rain on August 2 interfered with the establishment of the borers.



Percentage of Borer Survival
11
10
9
8
7
6
5
4
3
2
Single and double Cross strains of Corn - Exp. B.
Inbred Strains of Corn- Exp.C.
Tasseling Date
July 24 26 28 30 Aug 1 3 5 7 9-Exp.C
July 25 27 29 31 Aug. 2 4 6-Exp.B

Figure 1.-

When the rates of borer survival in tables 8 and 9 were plotted against the silking dates and against the number of days between tasseling and silking, respectively, and straight lines fitted to the plotted data, it was found that each day later in silking and each day less in the number of days between tasseling and silking was associated with a mean decrease of 0.256 and a mean decrease of 0.287, respectively, in the rate of borer survival. Since the number of days from tasseling to silking was fairly constant from group to group in table 8 and the mean silking date was fairly constant from group to group in table 9 it appears that a delay of a day in tassel eclosion had about the same effect in decreasing the rate of borer survival on the inbreds as an additional day in reaching the silking stage. This same conclusion was reached after treating the rate of borer survival as a joint function of the maturity of the strains and the delay in tassel eclosion in the single and double crosses of Experiment B.

At the time of tassel emergence, in late July and early August, the inbreds were observed frequently in order to determine those whose upper leaves remained wrapped around the emerging tassel longer than ordinary. Of the total 136 inbreds, 19 were so noted and 3 were questionable in this respect. Of the total 136 inbreds 28 silked 8.5 days or less after tasseling. Of the 28 inbreds 15 were those noted with the leaf wrappings and 3 were those considered questionable in this respect. The 28 inbreds with the accompanying data are given in table 10.

Table 10

Inbred	Days from tasseling to silking	Leaf wrapping present	Inbred	Days from tasseling to silking	Leaf wrapping present
Ky. 58	3.0	Yes	Iowa L234	7.9	Yes
Ohio 02	4.0	Yes	Minn. 156	7.9	Questionable
Kan. Y.S.56	4.5	Yes	Ind. B2	7.9	Yes
Ill. D3	5.8	No	Wis. 26	8.0	No
Mo. K7	5.8	Yes	Wis. 23	8.0	Yes
Mo. K4	6.0	Yes	Iowa I205	8.0	No
Ohio 61	6.4	Questionable	W.Va. 84	8.1	A tendency
W. Va. 22	6.4	A tendency	Ill. D8	8.1	No
Kan. 9018	6.5	Yes	Iowa U.S.153	8.2	No
Ill. R4	6.8	Yes	Iowa Bl 345	8.2	Yes
Ill. A48	6.9	Yes	Iowa 4 Co 82	8.3	No
Kan. Hg26	7.0	No	Minn. 40	8.3	No
Ill. S 55	7.3	Questionable	Ky. 21	8.3	Yes
Ill. St.22	7.4	Yes	Minn. 27	8.5	Yes

The wrapping of the leaves around the tassel was more pronounced in some of these inbreds than in others. Inbred Kan. YS-56, with broad crinkly leaves, was most pronounced in that respect. But it was one of the 5 latest in the experiment, silking on August 19. In fact, 10 of the 15 inbreds listed above with wrapping of leaves averaged 4.5 days later in silking than the average of 126 inbreds. However, on the other hand, delay in tassel eclosion, with or without noticeable leaf wrapping, showed no relation to date of silking (table 9). Inbreds Ill. R4 and Ky. 21 were also pronounced in wrapping the leaves around the tassel. Inbred Ind. B2, although listed with leaf wrapping, was not pronounced in this respect. Inbred Ky. 58, noted with leaf wrapping, delayed tassel eclosion more than any other inbred, only 3 days elapsing between tasseling and silking. This inbred had very broad leaves and it is possible these contributed to the extreme delay in tassel eclosion. Inbreds Bl 345 and Iowa L234 were noted with leaf wrapping, but the top leaves were short and narrow. It is possible the small leaves of these inbreds contributed to a shorter delay in tassel eclosion, 8.2 and 7.9 days, respectively, elapsing between tasseling and silking.

In addition to the 15 inbreds observed to possess leaf wrapping, and silking 8.5 days or less after tasseling, inbreds Ill. Hy, Iowa L317, and Ill. 5120 were observed to have leaves wrapping around the tassel and inbred W. Va. 23 with a tendency in this respect. But the top leaves of inbreds L317 and Ill. 5120 were noted as being short and narrow. Neither of these inbreds, when crossed with an inbred not delaying tassel eclosion, contributed to delaying tassel eclosion in the single cross. Inbred L317, however, when used in double crosses with inbreds having delayed tassel eclosion, contributed to a further delay in tassel eclosion and hence to greater resistance to the borer. Perhaps inbred 5120 would behave in double crosses in a similar manner. Although the delay in tassel eclosion of inbred Hy is about average, when combined with R4 the single cross is one of the most resistant to the borer because of the greatly delayed tassel eclosion.

The rate of borer survival on most of the inbreds discussed above was what would be expected on the basis of the date of tasseling and chance fluctuations in sampling. Any exceptions are noted in the section below.

BORER RESISTANCE DUE TO CAUSES OTHER THAN THE TASSELING OF THE INBREDS.

In order to assist in determining causes other than the tassel that might contribute to the borer resistance of individual inbreds, measurements were made of those physical and plant characters that might be expected to affect the rate of borer survival. These included the number of plants per hill, the heights of the inbreds and the amount of leaf area per unit height. A greater number of plants per hill or a greater density of the leaves has been found under some conditions to raise the rate of borer survival through, it is believed, the additional opportunities offered the newly hatched borers to regain a position on the plants after being blown off. Small borers blown off tall plants might be carried farther and hence gain a position on the plants across the row.

The heights of the inbreds on July 26 and the leaf area per unit height are given in table 6 also. Apparently, no relation existed between plant height and rate of borer survival in this experiment. This is shown from the data in table 11 obtained by grouping the inbreds according to their height and then according to silking date.

Table 11

Height in cm. on July 26 (mean of 18 inbreds)	Percentage of borer survival	Silking date	Height in cm. on July 26
172	9.08	35.8	155
162	11.17	38.1	151
156	9.37	39.5	150
150	8.96	40.6	155
144	8.72	42.1	150
138	10.03	43.8	149
127	8.48	47.6	145

The later silking inbreds were slightly shorter than the early silking inbreds and the shorter inbreds sustained a slightly lower rate of borer survival. Since it has been shown (table 8) that the rate of borer survival was markedly less on the later silking inbreds, it follows that the slightly lower rate of borer survival on the shorter inbreds was probably due to these inbreds silking later.

The inbreds were then grouped according to their index of bushiness and then according to silking date and the data averaged. The data are given in table 12.

Table 12

Sq. cms. leaf area Per cm. height-Index of bushiness	Percentage of borer survival	Silking date	Index of bushiness
19.4	9.97	35.8	23.7
22.1	9.43	38.1	25.2
23.8	8.48	39.5	24.5
24.9	9.85	40.6	26.9
26.1	9.37	42.1	23.0
27.9	9.31	43.8	26.0
30.3	8.54	47.6	26.0

The rate of borer survival decreases somewhat as the inbreds increase in bushiness. This is contrary to expectation. But the later silking inbreds tend to be more bushy and, as shown before, the rate of borer survival is lower on later silking inbreds. It follows, therefore, that the lower rate of borer survival on the more bushy inbreds was probably due to these inbreds silking later and not to any direct relation between bushiness and rate of survival.

As a further check on the effect of the density of leaves on the rate of borer survival the data from the various inbreds were tabulated according to the number of plants per hill, totaled and averaged for all inbreds. The data are given in table 13.

Table 13

Plant per hill	Total borers	Total plants	Percentage of borer survival
1	3111	390	8.58 ± .374
2	6978	790	9.50 ± .263
3	11534	1320	9.40 ± .203
4	11267	1348	8.99 ± .202

There was no definite tendency for the rate of borer survival to increase as the number of plants per hill increased. Aside from the rate of borer survival being least on the 1-plant hills, the trend in the rate is contrary to expectations when the other hills are considered. The standard errors as given were estimated from the within strain variability of the inbreds. Taking these into consideration and the fact that there is some strain-to-strain variability which cannot be estimated (the samples were not uniform respecting the inbreds composing them) it is doubtful if there is a significant difference between the 1-plant hills and the 2-, 3-, or 4-plant hills. On the basis of the variability between samples of the same strain there are no significant differences between 2-, 3-, or 4-plant hills.

The mean rate of borer survival on each inbred is given with the generalized standard error for that particular mean in table 6. Accompanying is the rate of borer survival estimated from the curve in figure 1 according to the tasseling date of the inbreds. The difference between the rate determined from the field data and the estimated rate is more than twice the standard error in the case of 18 inbreds. But an error through chance fluctuations in sampling greater than twice (plus and minus) the standard error would occur on the average 1 out of 20 cases. Of the 126 inbreds as many as 6 or 7 would thus deviate more than twice the standard error through chance fluctuations in sampling. Of these 6 inbreds 3 would, on the average, deviate negatively. Since 17 of the 18 inbreds under discussion had lower than the estimated values, 14 of the 17 probably had significantly lower rates of borer survival on them than would be expected on the basis of the time of tasseling. In arriving at the number of 14 inbreds with the significantly low rates of survival the standard errors of the rates of survival, estimated from the curve, are assumed to be so small, considering the number of inbreds used to define the curve of average relationship, that no consideration need be paid to them. Data for the 17 inbreds under discussion in the order of the magnitude of their deviation from the estimated values are given in table 14.

Table 14

Rank in extra borer resistance	Inbred	Silking date-days from June 30	Percentage of borer survival: Actual	Percentage of borer survival: Calculated	Rank in extra borer resistance	Inbred	Silking dates-days from June 30	Percentage of borer survival: Actual	Percentage of borer survival: Calculated
1	Iowa L317	46.8	3.3	7.2	6	Wis. 1342	39.4	7.3	10.4
2	N.Y. 19	39.0	6.3	10.6	6	Wis. 23	38.8	6.3	9.2
3	Mich. 77	44.7	4.4	7.5	7	Iowa I224	40.3	6.9	9.9
4	Ill. S31	38.4	6.9	10.4	8	Mich. 106	43.1	5.6	8.3
5	Ill. S1	41.2	7.2	10.5	9	Mich.M.A.225	45.8	5.7	8.3
5	Ohio 87	42.3	7.2	10.5	10	Ohio 32	40.2	7.3	10.0
5	Minn. 24	36.9	7.3	10.6	11	Iowa I 205	38.8	6.7	9.2
					12	Ill. R4	42.4	5.1	7.2
					13	Conn. 136	41.3	7.9	10.5
					14	Kans.Y.S.56	50.5	4.9	7.0
						Mean		6.3	9.5

The mean rate of borer survival determined from the field data from the 17 inbreds is 33.7 percent less than the mean rate estimated on the basis of the time of tasseling of the inbreds. If there are plant characters other than the tasseling of the inbreds that would cause a lower rate of survival of the borers it is among these 17 inbreds that they are most likely to be found. One of the 17 inbreds is Maize Amargo 225 already reported by Mr. A. R. Marston of Michigan to be borer resistant. Two others of the 17 are inbreds out of crosses between Maize Amargo and local varieties. It is of interest to note that inbred L 317 gave the lowest rate of borer survival of any inbred tested. Considering the varying reaction of this inbred in hybrid combination, noted in Experiment B and Experiment A, it is especially important to give this inbred close observation. No reasons are known why any of the other inbreds should sustain significantly lower rates of borer survival than their tasseling dates would indicate.